SLOPE STABILITY ANALYSIS OF EARTHDAM:

Earth Dams are usually constructed using the locally available soil. The soil properties used for construction of earth dam are important in design of slopes. Civil engineers involved in design and construction of earth dams know the difficulty of design of slopes for stability of earth dams. I worked as Assistant Engineer in Design Circle in 1999 in Tamilnadu Public Works Department. At that time I saw many engineers involved in design of earth dams working on A0-size graph sheets drawing the cross section and draw a slip circle. Then they will create many vertical slices of Earth dam portion and calculate the area of slices below MWL/FRL/DDL of SPZ/IPZ and take the moments of weight of slices and resisting forces and put them in tabular form in the graph sheet itself to find the factor of safety as per IS Code(Indian Standard code). The area is calculated by counting the number of squares manually from the graph sheet. The notations above are

MWL- Maximum water level
FRL - Full Reservoir Level
DDL – Draw Down Level
SPZ - Semi Permeable Zone(Outer Zone of earth dam)
IPZ - ImPermeable Zone(Inner Zone of earth dam)
spzblk- Bulk Density of Semi Pervious Zone soil
ipzblk- Bulk Density of Im Pervious Zone soil
spzsub- Submerged Density of Semipervious zone
ipzsub- Submerged Density of Impervious zone
spzsat- Saturated Density of Semipervious zone
ipzsat- Saturated Density of Impervious zone

usually 6 trials for upstream and 6 trials for downstream are done for arriving at the minimum factor of safety against failure. Roughly one month will be taken to do the 12 no of trials and factor of safety for the worst condition is found out. After seeing the laborious work involved in that process, I develop a program in AutoLisp to work in Autocad with one input table in Visual Basic for AutoCAD. This program made the design of slope stability in one minute in Autocad.

You can download that STABILITY.RAR file from the following link.

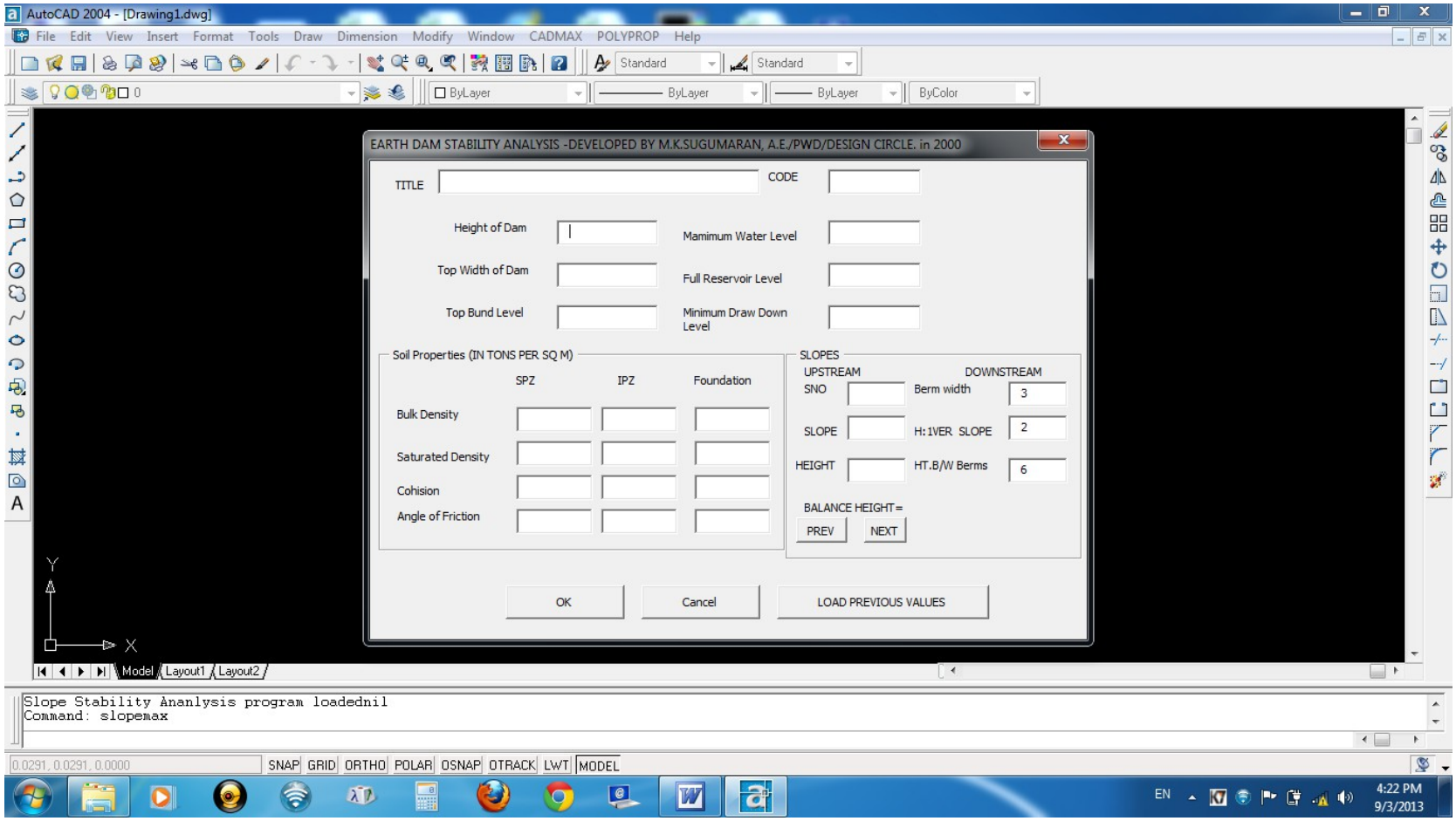
http://rapidshare.com/files/298210933/STABILITY.rar

After that you unzip the STABILITY.RAR file and save them in a folder C:\STABILITY

From AutoCAD shortcut on the Desktop create another new shortcut. Rename that new shortcut as “Stability”. Then Right click on the Stability- Icon and click on properties. In the start in text box type folder name as C:\STABILITY and then click apply and close it.

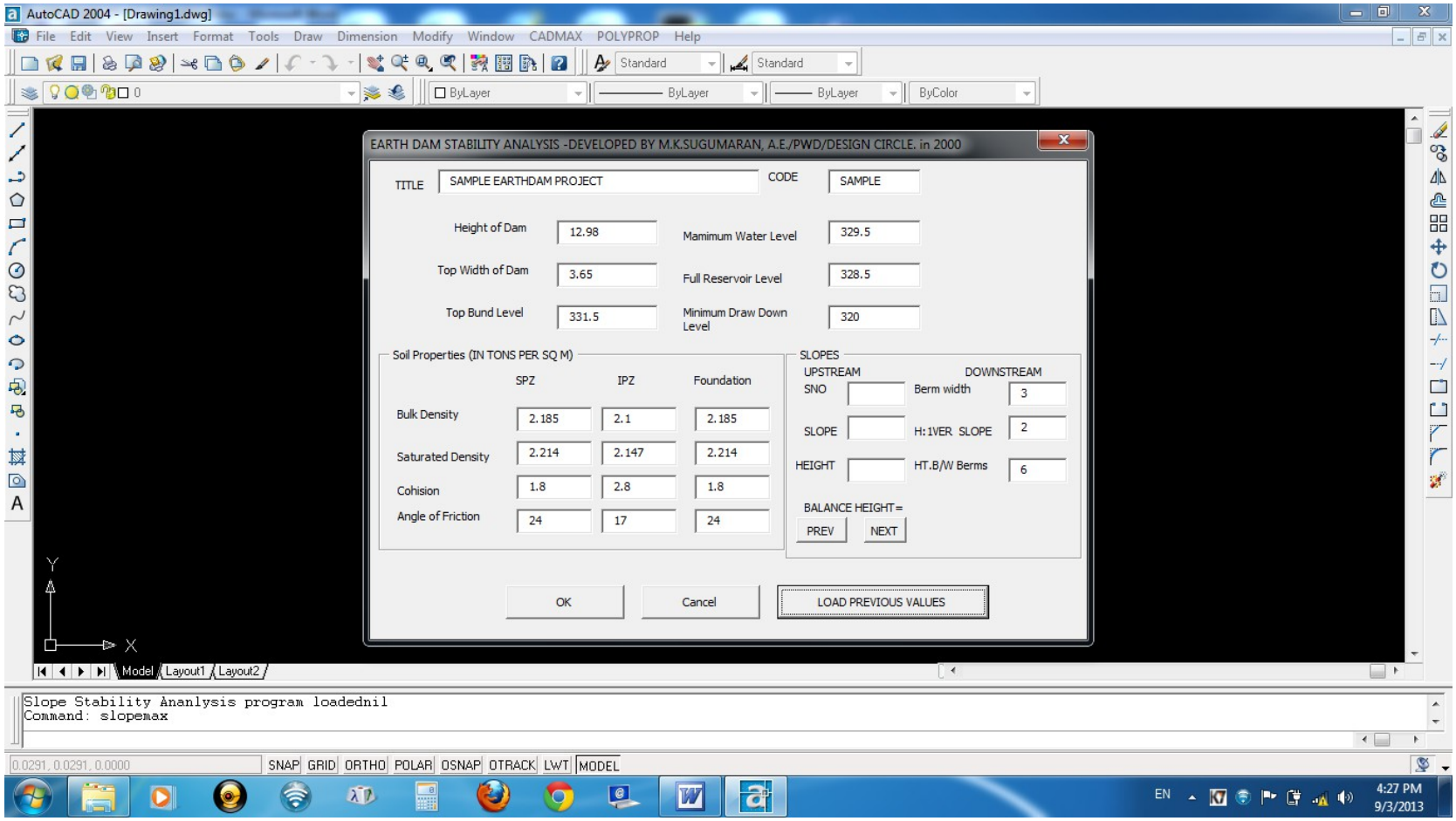
Now Click on the Stability icon to start Autocad.

Step.1.
In the command prompt give (load”stability”) as follows.
command:(load”stability”)
The Slope stability program loadednil
command:
Step.2.
In the command prompt give slopemax command as follows.
command:slopemax
Step 3.
You will see the following screen.



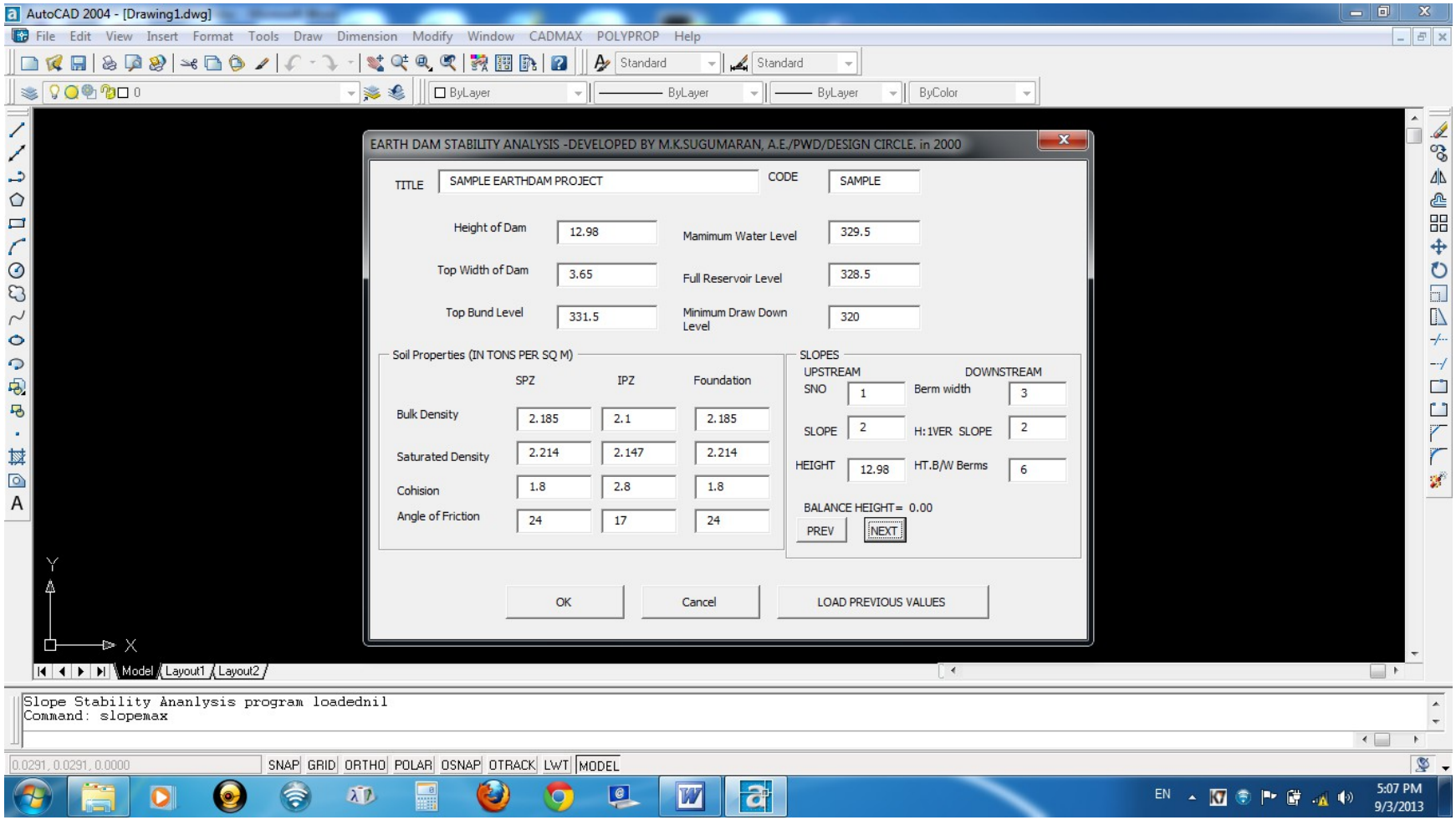
Step 4.

You can enter the values directly in the text boxes or you can click –"LOADPREVIOUSVALUES" button and edit the values. By clicking the "LOADPREVIOUSVALUES" button you will see the following screen filled with some values.

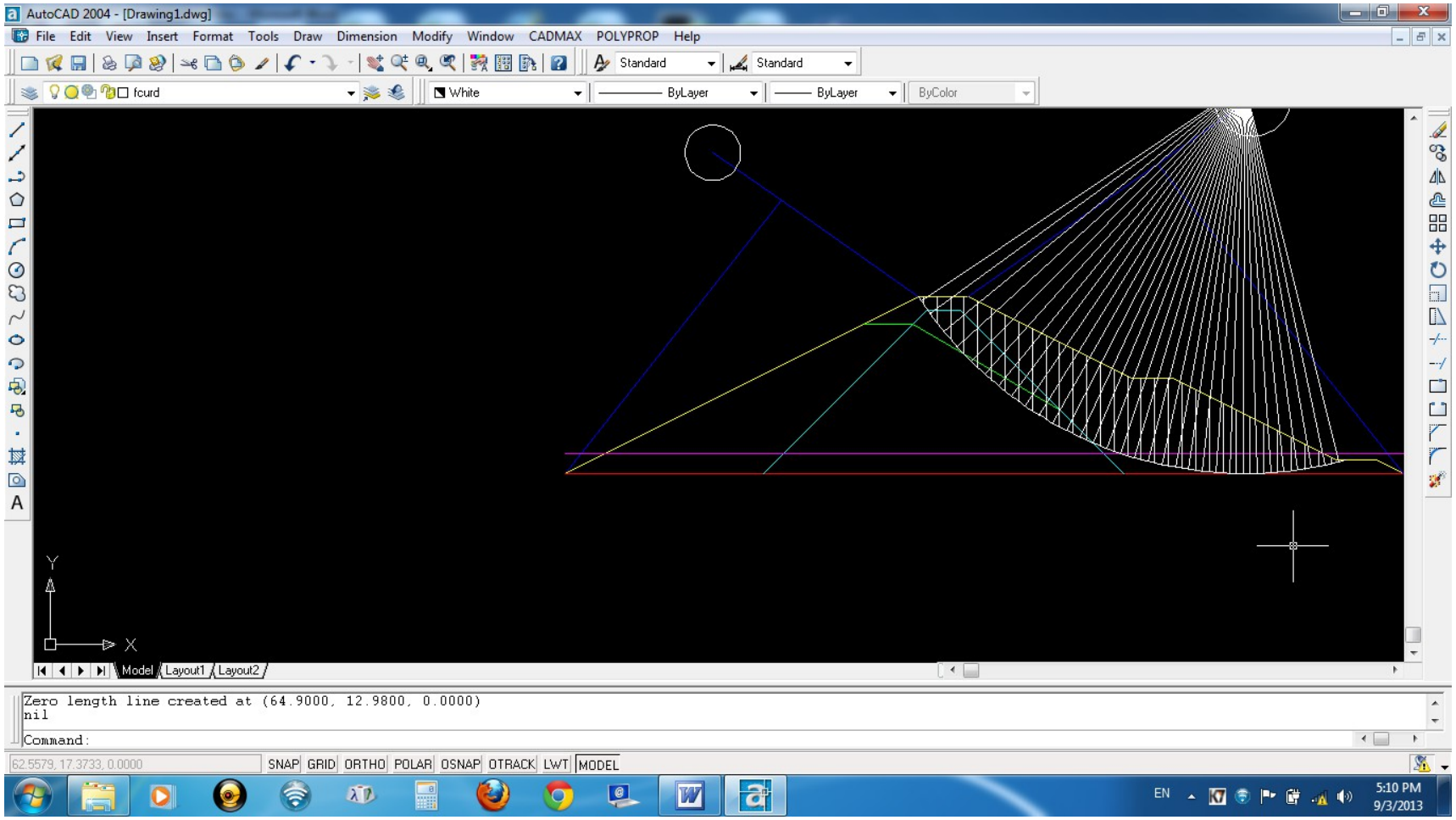


TITLE- SAMPLE EARTHDAM PROJECT
CODE-SAMPLE
Height of Dam(in Metres) - 12.98
Top Width of Dam(in Metres) - 3.65
Top Bund Level(in Metres MSL) – 331.5

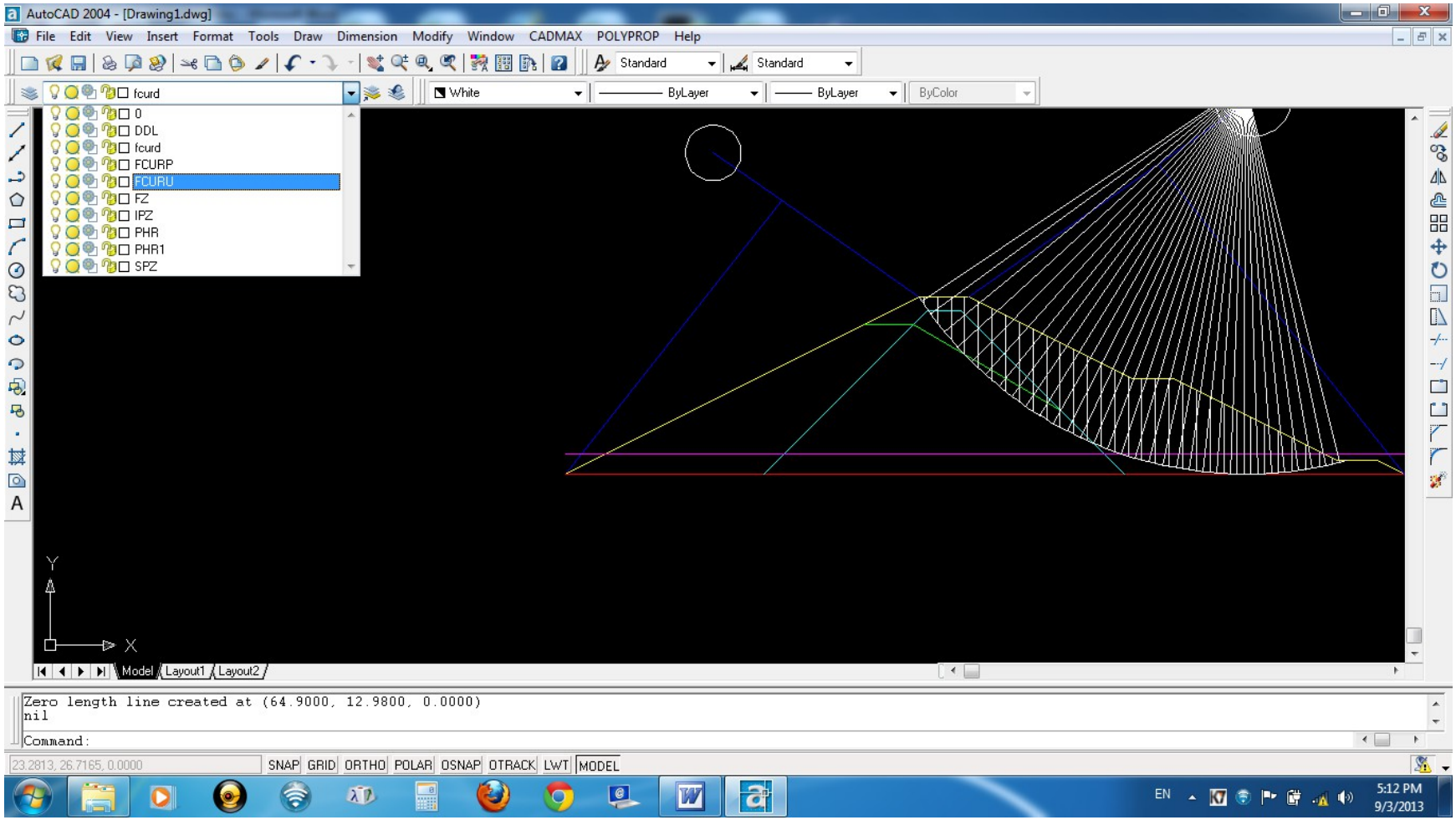
Maximum Water level(in M. MSL) –329.5
Full Resrvoir Level(in M.MSL) -328.5
Minimum DrawDown Level(in M MSL) – 320
Soil Properties in Tons/SQ.M
SPZ Bulk Density -2.185
SPZ Saturated Density -2.214
SPZ Cohesion -1.8
SPZ Angle of Friction in Degrees -24
IPZ Bulk Density -2.1
IPZ Saturated Density -2.147
IPZ Cohesion -2.8
IPZ Angle of Friction in Degrees -17
Foundation Bulk Density -2.185
Foundation Saturated Density -2.214
Foundation Cohesion -1.8
Foundation Angle of Friction in Degrees -24
Slopes Downstream
Berm width (in Metres) - 3
Slope Hor : 1 Ver - 2
Height between Berms (in Metres) - 6
Slopes Upstream
(blank and to be filled as follows)
S.NO. -1
Slope (Hor : 1 Ver) -2
Height -12.98
then click –NEXT button
You will see the Label Balance Height = 0.00
(It means the Full height of 12.98m is to be designed as 2:1 slope and you can use 2 slopes also as top 6m in 2:1 slope and bottom remaining 6.98m in 2.5:1 slope also. The slopes shall be given in such a way that balance height=0.00)
Now the screen will be as shown below.



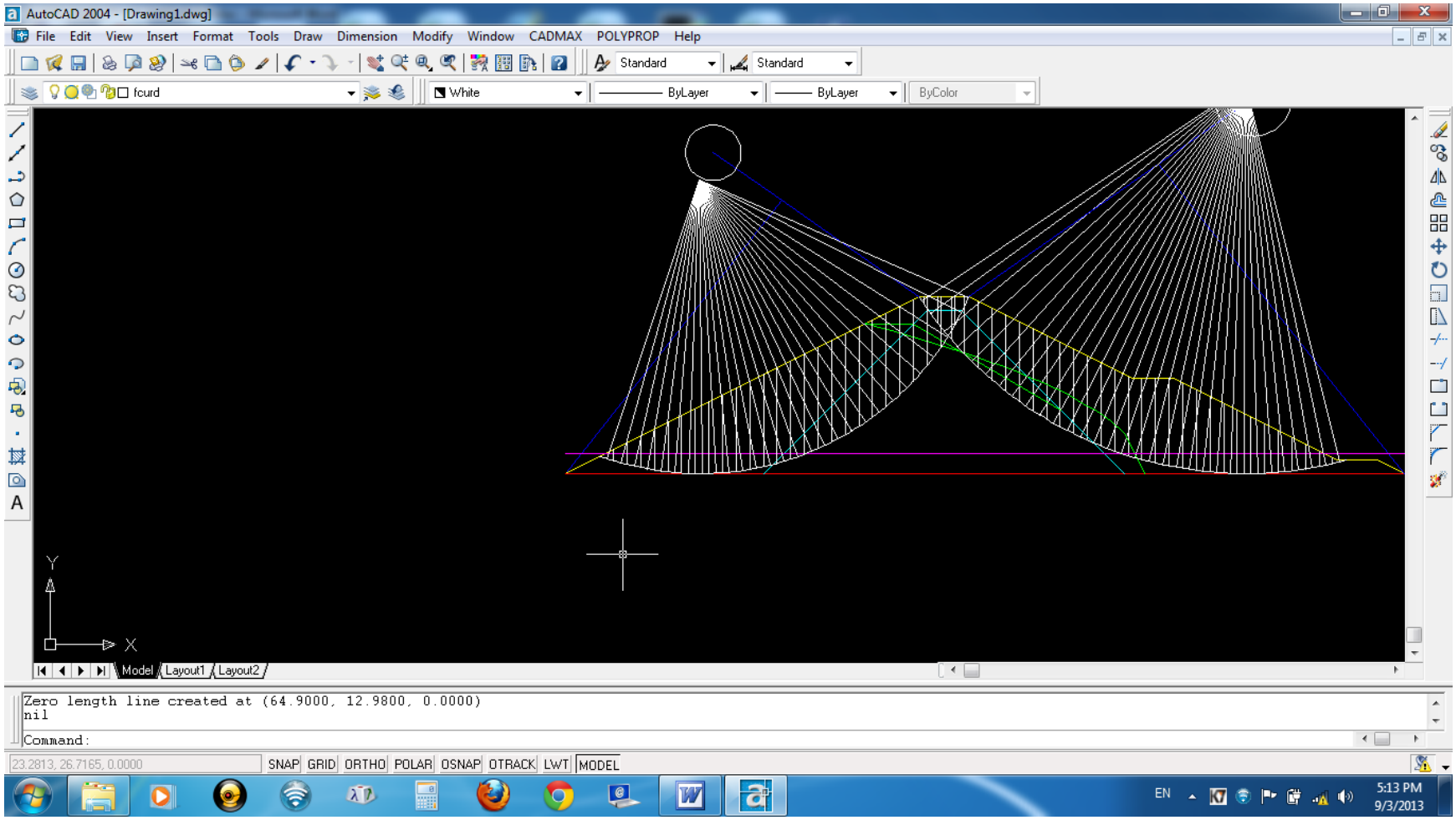
Now click OK button. The screen will disappear and following screen will appear in AutoCAD graphical area.



You will see only the downstream Slip Circle. The Upstream slip circle is drawn and the layer is switched off. You can switch the layer on as follows.



FCURU layer is on you will see the following screen.



So both the Upstream and downstream slip circle analysis is over. Ignore the error message of Zreo length it is a warning of autocad when a line of zero length is created. The upstream analysis is stored in the file SAMPLE.UPS and downstream analysis is stored in the file SAMPLE.DWS. Those files can be opened in notepad and seen as given below.

SAMPLE.UPS FILE IN NOTEPAD

SAMPLE EARTHDAM PROJECT
UPSTREAM- EARTHDAM STABILITY ANALYSIS CALCULATION SHEET:

S.no	AREA m2	ANGLE A-deg	MATERI -AL	UNIT WEIGHT	WT.SLICE W-TON	N=W*COSA TON	FI DEG	N*TAN(FI) TON	MATERI -AL	UNIT WEIGHT	WT.SLICE W1-TON	T=W*SINA TON	T*TAN(FI) Ti(TON)	W1*COSA (TON)
1a1	0.268	-18.42	spzsub	1.214	0.326	0.309	24	0.138	spzsub	1.214	0.326	-0.103	-0.046	0.309
1a2	0.148	-18.42	spzsub	1.214	0.180	0.171	24	0.076	spzsat	2.214	0.328	-0.104	-0.046	0.311
2a1	0.677	-15.64	spzsub	1.214	0.822	0.791	24	0.352	spzsub	1.214	0.822	-0.221	-0.099	0.791
2a2	0.546	-15.64	spzsub	1.214	0.663	0.639	24	0.284	spzsat	2.214	1.210	-0.326	-0.145	1.165
3a1	0.931	-12.89	spzsub	1.214	1.131	1.102	24	0.491	spzsub	1.214	1.131	-0.252	-0.112	1.102
3a2	1.046	-12.89	spzsub	1.214	1.270	1.238	24	0.551	spzsat	2.214	2.317	-0.517	-0.230	2.258
4a1	1.136	-10.17	spzsub	1.214	1.379	1.357	24	0.604	spzsub	1.214	1.379	-0.243	-0.108	1.357
4a2	1.546	-10.17	spzsub	1.214	1.877	1.848	24	0.823	spzsat	2.214	3.424	-0.605	-0.269	3.370
5a1	1.291	-7.48	spzsub	1.214	1.567	1.554	24	0.692	spzsub	1.214	1.567	-0.204	-0.091	1.554
5a2	2.046	-7.48	spzsub	1.214	2.484	2.463	24	1.097	spzsat	2.214	4.531	-0.590	-0.263	4.492
6a1	1.399	-4.80	spzsub	1.214	1.698	1.692	24	0.753	spzsub	1.214	1.698	-0.142	-0.063	1.692
6a2	2.546	-4.80	spzsub	1.214	3.091	3.080	24	1.371	spzsat	2.214	5.638	-0.472	-0.210	5.618
7a1	1.459	-2.13	spzsub	1.214	1.772	1.770	24	0.788	spzsub	1.214	1.772	-0.066	-0.029	1.770
7a2	3.046	-2.13	spzsub	1.214	3.698	3.696	24	1.645	spzsat	2.214	6.745	-0.251	-0.112	6.740
8a1	1.473	0.53	spzsub	1.214	1.789	1.788	24	0.796	spzsub	1.214	1.789	0.016	0.007	1.788
8a2	3.546	0.53	spzsub	1.214	4.305	4.305	24	1.917	spzsat	2.214	7.852	0.072	0.032	7.851
9a1	1.441	3.19	spzsub	1.214	1.749	1.746	24	0.778	spzsub	1.214	1.749	0.097	0.043	1.746
9a2	4.046	3.19	spzsub	1.214	4.912	4.905	24	2.184	spzsat	2.214	8.959	0.499	0.222	8.945
10a1	1.362	5.86	spzsub	1.214	1.653	1.644	24	0.732	spzsub	1.214	1.653	0.169	0.075	1.644
10a2	4.546	5.86	spzsub	1.214	5.519	5.490	24	2.444	spzsat	2.214	10.066	1.028	0.458	10.013
11a1	1.235	8.55	spzsub	1.214	1.499	1.483	24	0.660	spzsub	1.214	1.499	0.223	0.099	1.483
11a2	5.046	8.55	spzsub	1.214	6.126	6.058	24	2.697	spzsat	2.214	11.173	1.660	0.739	11.048
12a1	1.060	11.25	spzsub	1.214	1.287	1.263	24	0.562	spzsub	1.214	1.287	0.251	0.112	1.263
12a2	5.546	11.25	spzsub	1.214	6.733	6.604	24	2.940	spzsat	2.214	12.280	2.395	1.066	12.044
13a1	0.722	13.98	spzsub	1.214	0.876	0.850	24	0.379	spzsub	1.214	0.876	0.212	0.094	0.850
13a2	6.046	13.98	spzsub	1.214	7.340	7.123	24	3.171	spzsat	2.214	13.387	3.233	1.439	12.990
13a3	0.115	13.98	ipzsub	1.147	0.132	0.128	17	0.039	ipzsub	1.147	0.132	0.032	0.010	0.128
14a2	6.529	16.74	spzsub	1.214	7.926	7.590	24	3.379	spzsat	2.214	14.455	4.162	1.853	13.842
14a3	0.562	16.74	ipzsub	1.147	0.644	0.617	17	0.189	ipzsub	1.147	0.644	0.185	0.057	0.617

14a4	0.018	16.74	ipzsub	1.147	0.020	0.019	17	0.006	ipzsat	2.147	0.038	0.011	0.003	0.036
15a2	6.029	19.54	spzsub	1.214	7.319	6.897	24	3.071	spzsat	2.214	13.348	4.464	1.987	12.579
15a3	0.234	19.54	ipzsub	1.147	0.268	0.253	17	0.077	ipzsub	1.147	0.268	0.090	0.027	0.253
15a4	1.018	19.54	ipzsub	1.147	1.167	1.100	17	0.336	ipzsat	2.147	2.185	0.731	0.223	2.059
16a2	5.529	22.39	spzsub	1.214	6.712	6.206	24	2.763	spzsat	2.214	12.241	4.662	2.076	11.318
16a3	0.028	22.39	ipzsub	1.147	0.032	0.030	17	0.009	ipzsub	1.147	0.032	0.012	0.004	0.030
16a4	1.840	22.39	ipzsub	1.147	2.110	1.951	17	0.596	ipzsat	2.147	3.950	1.504	0.460	3.652
17a2	5.029	25.30	spzsub	1.214	6.105	5.519	24	2.457	spzsat	2.214	11.134	4.758	2.118	10.066
17a4	2.425	25.30	ipzsub	1.147	2.782	2.515	17	0.769	ipzsat	2.147	5.207	2.225	0.680	4.708
18a2	4.529	28.28	spzsub	1.214	5.498	4.842	24	2.156	spzsat	2.214	10.027	4.751	2.115	8.830
18a4	2.920	28.28	ipzsub	1.147	3.349	2.949	17	0.902	ipzsat	2.147	6.269	2.970	0.908	5.520
19a2	4.029	31.35	spzsub	1.214	4.891	4.177	24	1.860	spzsat	2.214	8.920	4.641	2.066	7.617
19a4	3.346	31.35	ipzsub	1.147	3.838	3.277	17	1.002	ipzsat	2.147	7.183	3.737	1.143	6.135
20a4	3.418	34.52	ipzsub	1.147	3.920	3.230	17	0.987	ipzsat	2.147	7.338	4.158	1.271	6.045
20a5	3.529	34.52	spzblk	2.185	7.710	6.352	24	2.828	spzblk	2.185	7.710	4.370	1.945	6.352
20a6	0.279	34.52	ipzblk	2.100	0.587	0.483	17	0.148	ipzblk	2.100	0.587	0.332	0.102	0.483
21a2	2.482	37.82	spzsub	1.214	3.014	2.381	24	1.060	spzsat	2.214	5.496	3.370	1.500	4.342
21a4	3.964	37.82	ipzsub	1.147	4.547	3.592	17	1.098	ipzsat	2.147	8.512	5.219	1.596	6.724
21a5	0.546	37.82	spzblk	2.185	1.194	0.943	24	0.420	spzblk	2.185	1.194	0.732	0.326	0.943
22a2	1.482	41.27	spzsub	1.214	1.800	1.353	24	0.602	spzsat	2.214	3.282	2.165	0.964	2.467
22a4	4.137	41.27	ipzsub	1.147	4.745	3.566	17	1.090	ipzsat	2.147	8.882	5.859	1.791	6.675
22a5	1.046	41.27	spzblk	2.185	2.286	1.718	24	0.765	spzblk	2.185	2.286	1.508	0.671	1.718
23a2	0.477	44.92	spzsub	1.214	0.579	0.410	24	0.183	spzsat	2.214	1.057	0.746	0.332	0.748
23a4	4.198	44.92	ipzsub	1.147	4.816	3.410	17	1.043	ipzsat	2.147	9.014	6.365	1.946	6.383
23a5	1.551	44.92	spzblk	2.185	3.390	2.400	24	1.069	spzblk	2.185	3.390	2.394	1.066	2.400
24a4	3.307	48.81	ipzsub	1.147	3.794	2.498	17	0.764	ipzsat	2.147	7.101	5.344	1.634	4.676
24a5	1.389	48.81	spzblk	2.185	3.036	1.999	24	0.890	spzblk	2.185	3.036	2.285	1.017	1.999
24a6	0.811	48.81	ipzblk	2.100	1.703	1.121	17	0.343	ipzblk	2.100	1.703	1.282	0.392	1.121
25a4	1.486	53.04	ipzsub	1.147	1.704	1.025	17	0.313	ipzsat	2.147	3.190	2.549	0.779	1.918
25a5	1.000	53.04	spzblk	2.185	2.185	1.314	24	0.585	spzblk	2.185	2.185	1.746	0.777	1.314
25a6	1.886	53.04	ipzblk	2.100	3.960	2.381	17	0.728	ipzblk	2.100	3.960	3.164	0.967	2.381
26a4	0.264	57.72	ipzsub	1.147	0.303	0.162	17	0.049	ipzsat	2.147	0.567	0.479	0.146	0.303
26a5	1.000	57.72	spzblk	2.185	2.185	1.167	24	0.519	spzblk	2.185	2.185	1.847	0.823	1.167
26a6	1.647	57.72	ipzblk	2.100	3.460	1.848	17	0.565	ipzblk	2.100	3.460	2.925	0.894	1.848
27a2	0.566	63.12	spzsub	1.214	0.687	0.311	24	0.138	spzsat	2.214	1.253	1.117	0.497	0.566
27a4	0.559	63.12	ipzsub	1.147	0.641	0.290	17	0.089	ipzsat	2.147	1.199	1.070	0.327	0.542
28a2	0.004	66.42	spzsub	1.214	0.005	0.002	24	0.001	spzsat	2.214	0.008	0.008	0.003	0.003
				Total	64.815				105.728	40.064	254.703

Total cohesive force = 76.847
Total resistant force with out earthquake = 141.662
Factor of safety with out earthquake = 1.340>= 1.30 Hence Safe.
Total resistant force with earthquake = 139.258
Factor of safety with earthquake = 1.151>= 1.00 Hence Safe.

SAMPLE.DWS FILE IN NOTEPAD
SAMPLE EARTHDAM PROJECT
DOWNSTREAM- EARTHDAM STABILITY ANALYSIS CALCULATION SHEET:

S.no	AREA m2	ANGLE A-deg	MATERI -AL	UNIT WEIGHT	WT.SLICE W-TON	N=W*COSA TON	FI DEG	N*TAN(FI) TON	MATERI -AL	UNIT WEIGHT	WT.SLICE W1-TON	T=W*SINA TON	T*TAN(FI) Ti(TON)	W1*COSA (TON)
1a1	0.199	-14.02	spzsub	1.214	0.241	0.234	24	0.104	spzsub	1.214	0.241	-0.058	-0.026	0.234
2a1	0.679	-11.96	spzsub	1.214	0.825	0.807	24	0.359	spzsub	1.214	0.825	-0.171	-0.076	0.807

2a2	0.074	-11.96	spzblk	2.185	0.161	0.158	24	0.070	spzblk	2.185	0.161	-0.033	-0.015	0.158
3a1	1.049	-9.91	spzsub	1.214	1.273	1.254	24	0.558	spzsub	1.214	1.273	-0.219	-0.098	1.254
3a2	0.398	-9.91	spzblk	2.185	0.869	0.856	24	0.381	spzblk	2.185	0.869	-0.150	-0.067	0.856
4a1	1.206	-7.88	spzsub	1.214	1.464	1.450	24	0.645	spzsub	1.214	1.464	-0.201	-0.089	1.450
4a2	0.898	-7.88	spzblk	2.185	1.962	1.943	24	0.865	spzblk	2.185	1.962	-0.269	-0.120	1.943
5a1	1.326	-5.86	spzsub	1.214	1.610	1.602	24	0.713	spzsub	1.214	1.610	-0.164	-0.073	1.602
5a2	1.398	-5.86	spzblk	2.185	3.054	3.038	24	1.353	spzblk	2.185	3.054	-0.312	-0.139	3.038
6a1	1.411	-3.85	spzsub	1.214	1.713	1.709	24	0.761	spzsub	1.214	1.713	-0.115	-0.051	1.709
6a2	1.898	-3.85	spzblk	2.185	4.147	4.137	24	1.842	spzblk	2.185	4.147	-0.278	-0.124	4.137
7a1	1.461	-1.84	spzsub	1.214	1.774	1.773	24	0.789	spzsub	1.214	1.774	-0.057	-0.025	1.773
7a2	2.398	-1.84	spzblk	2.185	5.239	5.236	24	2.331	spzblk	2.185	5.239	-0.168	-0.075	5.236
8a1	1.476	0.17	spzsub	1.214	1.791	1.791	24	0.798	spzsub	1.214	1.791	0.005	0.002	1.791
8a2	2.898	0.17	spzblk	2.185	6.332	6.332	24	2.819	spzblk	2.185	6.332	0.018	0.008	6.332
9a1	1.455	2.17	spzsub	1.214	1.766	1.765	24	0.786	spzsub	1.214	1.766	0.067	0.030	1.765
9a2	3.398	2.17	spzblk	2.185	7.424	7.419	24	3.303	spzblk	2.185	7.424	0.281	0.125	7.419
10a1	1.400	4.18	spzsub	1.214	1.699	1.695	24	0.754	spzsub	1.214	1.699	0.124	0.055	1.695
10a2	3.898	4.18	spzblk	2.185	8.517	8.494	24	3.782	spzblk	2.185	8.517	0.621	0.276	8.494
11a1	1.309	6.20	spzsub	1.214	1.589	1.580	24	0.703	spzsub	1.214	1.589	0.171	0.076	1.580
11a2	4.398	6.20	spzblk	2.185	9.609	9.553	24	4.253	spzblk	2.185	9.609	1.037	0.462	9.553
12a1	1.182	8.22	spzsub	1.214	1.435	1.420	24	0.632	spzsub	1.214	1.435	0.205	0.091	1.420
12a2	4.898	8.22	spzblk	2.185	10.702	10.592	24	4.716	spzblk	2.185	10.702	1.530	0.681	10.592
13a1	1.020	10.25	spzsub	1.214	1.238	1.218	24	0.542	spzsub	1.214	1.238	0.220	0.098	1.218
13a2	5.324	10.25	spzblk	2.185	11.633	11.447	24	5.097	spzblk	2.185	11.633	2.070	0.922	11.447
14a1	0.820	12.30	spzsub	1.214	0.996	0.973	24	0.433	spzsub	1.214	0.996	0.212	0.094	0.973
14a2	5.500	12.30	spzblk	2.185	12.017	11.742	24	5.228	spzblk	2.185	12.017	2.559	1.139	11.742
15a1	0.583	14.36	spzsub	1.214	0.708	0.686	24	0.305	spzsub	1.214	0.708	0.176	0.078	0.686
15a2	5.500	14.36	spzblk	2.185	12.018	11.642	24	5.183	spzblk	2.185	12.018	2.980	1.327	11.642
16a1	0.308	16.44	spzsub	1.214	0.373	0.358	24	0.159	spzsub	1.214	0.373	0.106	0.047	0.358
16a2	5.574	16.44	spzblk	2.185	12.179	11.681	24	5.201	spzblk	2.185	12.179	3.446	1.534	11.681
17a1	0.080	18.54	spzsub	1.214	0.097	0.092	24	0.041	spzsub	1.214	0.097	0.031	0.014	0.092
17a2	5.810	18.54	spzblk	2.185	12.695	12.036	24	5.359	spzblk	2.185	12.695	4.037	1.797	12.036
18a2	6.034	20.67	spzblk	2.185	13.183	12.335	24	5.492	spzblk	2.185	13.183	4.654	2.072	12.335
19a4	0.123	22.83	ipzsub	1.147	0.141	0.130	17	0.040	ipzsat	2.147	0.265	0.103	0.031	0.244
19a5	6.011	22.83	spzblk	2.185	13.134	12.105	24	5.390	spzblk	2.185	13.134	5.096	2.269	12.105
20a4	0.513	25.03	ipzsub	1.147	0.589	0.533	17	0.163	ipzsat	2.147	1.102	0.466	0.142	0.998
20a5	5.677	25.03	spzblk	2.185	12.405	11.240	24	5.004	spzblk	2.185	12.405	5.248	2.336	11.240
21a4	1.015	27.26	ipzsub	1.147	1.165	1.035	17	0.316	ipzsat	2.147	2.180	0.998	0.305	1.938
21a5	5.177	27.26	spzblk	2.185	11.312	10.056	24	4.477	spzblk	2.185	11.312	5.182	2.307	10.056
21a6	0.007	27.26	ipzblk	2.100	0.014	0.012	17	0.004	ipzblk	2.100	0.014	0.006	0.002	0.012
22a4	1.259	29.54	ipzsub	1.147	1.445	1.257	17	0.384	ipzsat	2.147	2.704	1.333	0.408	2.352
22a5	4.677	29.54	spzblk	2.185	10.220	8.891	24	3.959	spzblk	2.185	10.220	5.039	2.243	8.891
22a6	0.221	29.54	ipzblk	2.100	0.465	0.404	17	0.124	ipzblk	2.100	0.465	0.229	0.070	0.404
23a4	1.249	31.87	ipzsub	1.147	1.432	1.216	17	0.372	ipzsat	2.147	2.681	1.416	0.433	2.277
23a5	4.177	31.87	spzblk	2.185	9.127	7.751	24	3.451	spzblk	2.185	9.127	4.820	2.146	7.751
23a6	0.638	31.87	ipzblk	2.100	1.339	1.137	17	0.348	ipzblk	2.100	1.339	0.707	0.216	1.137
24a4	1.181	34.27	ipzsub	1.147	1.354	1.119	17	0.342	ipzsat	2.147	2.535	1.427	0.436	2.095
24a5	3.677	34.27	spzblk	2.185	8.035	6.640	24	2.956	spzblk	2.185	8.035	4.524	2.014	6.640
24a6	1.054	34.27	ipzblk	2.100	2.213	1.829	17	0.559	ipzblk	2.100	2.213	1.246	0.381	1.829
25a4	1.050	36.73	ipzsub	1.147	1.205	0.966	17	0.295	ipzsat	2.147	2.255	1.349	0.412	1.807
25a5	3.177	36.73	spzblk	2.185	6.942	5.564	24	2.477	spzblk	2.185	6.942	4.152	1.849	5.564
25a6	1.470	36.73	ipzblk	2.100	3.087	2.474	17	0.756	ipzblk	2.100	3.087	1.846	0.564	2.474
26a4	0.852	39.28	ipzsub	1.147	0.977	0.756	17	0.231	ipzsat	2.147	1.829	1.158	0.354	1.416
26a5	2.677	39.28	spzblk	2.185	5.850	4.528	24	2.016	spzblk	2.185	5.850	3.704	1.649	4.528
26a6	1.886	39.28	ipzblk	2.100	3.961	3.066	17	0.937	ipzblk	2.100	3.961	2.508	0.767	3.066

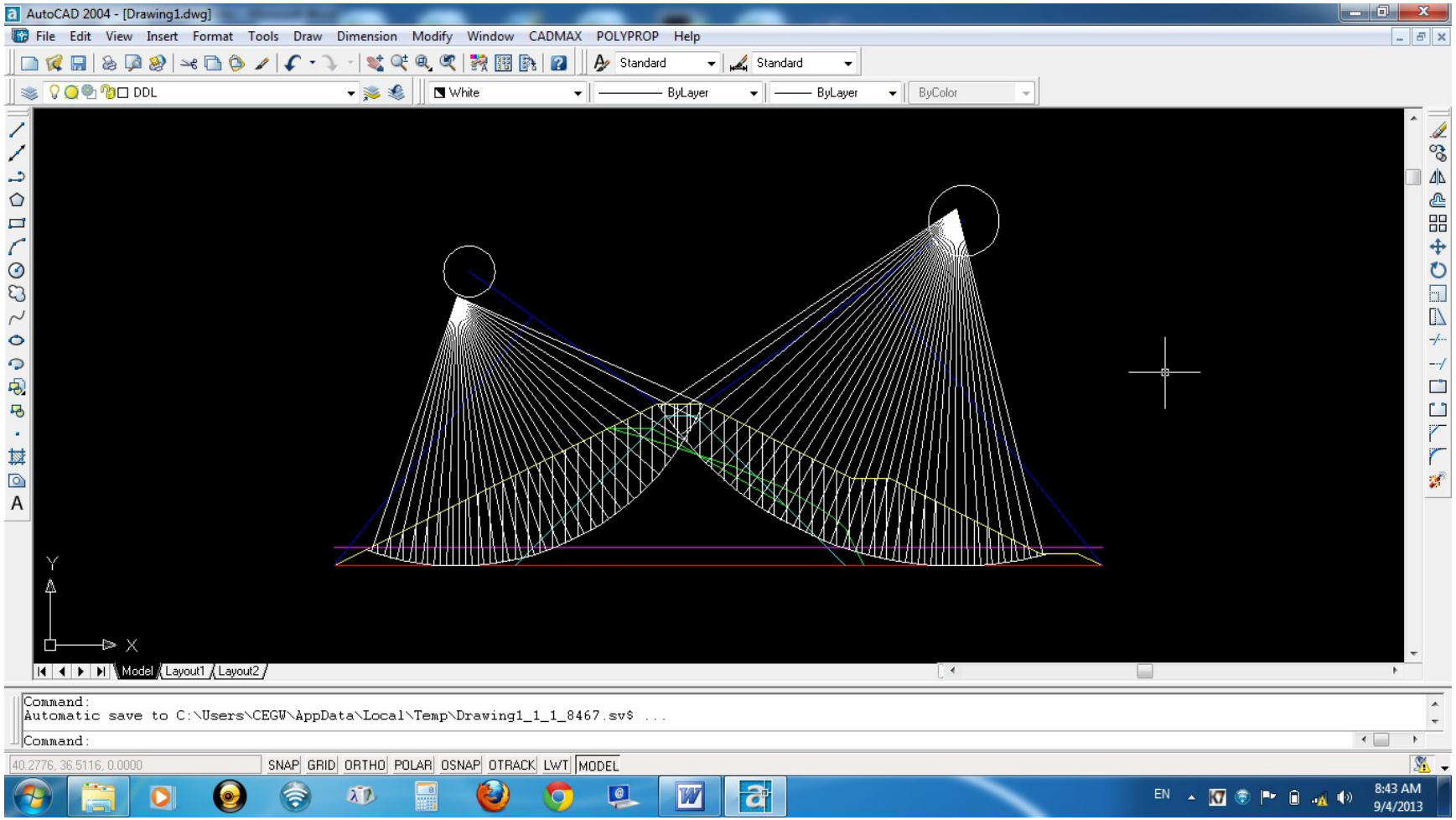
27a4	0.577	41.92	ipzsub	1.147	0.662	0.493	17	0.151	ipzsat	2.147	1.239	0.828	0.253	0.922
27a5	2.177	41.92	spzblk	2.185	4.757	3.540	24	1.576	spzblk	2.185	4.757	3.178	1.415	3.540
27a6	2.303	41.92	ipzblk	2.100	4.835	3.598	17	1.100	ipzblk	2.100	4.835	3.231	0.988	3.598
28a4	0.217	44.68	ipzsub	1.147	0.249	0.177	17	0.054	ipzsat	2.147	0.466	0.328	0.100	0.331
28a5	1.603	44.68	spzblk	2.185	3.503	2.491	24	1.109	spzblk	2.185	3.503	2.463	1.097	2.491
28a6	2.719	44.68	ipzblk	2.100	5.709	4.060	17	1.241	ipzblk	2.100	5.709	4.014	1.227	4.060
29a4	0.007	47.57	ipzsub	1.147	0.008	0.006	17	0.002	ipzsat	2.147	0.015	0.011	0.003	0.010
29a5	1.140	47.57	spzblk	2.185	2.490	1.680	24	0.748	spzblk	2.185	2.490	1.838	0.818	1.680
29a6	2.526	47.57	ipzblk	2.100	5.305	3.579	17	1.094	ipzblk	2.100	5.305	3.916	1.197	3.579
30a2	1.000	50.64	spzblk	2.185	2.185	1.386	24	0.617	spzblk	2.185	2.185	1.689	0.752	1.386
30a4	1.516	50.64	ipzsub	1.147	1.738	1.103	17	0.337	ipzsat	2.147	3.254	2.516	0.769	2.064
31a2	0.766	53.92	spzblk	2.185	1.673	0.985	24	0.439	spzblk	2.185	1.673	1.352	0.602	0.985
31a4	0.453	53.92	ipzsub	1.147	0.519	0.306	17	0.094	ipzsat	2.147	0.972	0.786	0.240	0.572
32a2	0.094	56.29	spzblk	2.185	0.206	0.114	24	0.051	spzblk	2.185	0.206	0.171	0.076	0.114
				Total		109.574					101.233	40.828	263.205	

```
Total cohesive force =         80.318
Total resistant force with out earthquake =        189.892
Factor of safety with out earthquake      =          1.876>= 1.30 Hence Safe.
Total resistant force with earthquake     =        187.443
Factor of safety with earthquake          =          1.602>= 1.00 Hence Safe.
```

So both the Upstream and downstream slip circle analysis is over and both the slopes are safe. If unsafe is appeared in the above files slopes to be revised to further mild slopes(i.e. reduce 2:1 to 2.5:1). If factor of safety is more safe (i.e.1.876 >=1.30) the slopes may be revised to steeper slopes(i.e.increase 2:1 to 1.5:1). This program of stability analysis in AutoCAD environment made the job so easy.

Detailed Drawing of earth dam for Construction:

After stability analysis, detailed construction drawing has to be supplied to the field engineers. Detailing of Earth dam is also included in this software.
At the command prompt give “damsec” command. Before giving “damsec” command pan the display portion to the center of screen as below)



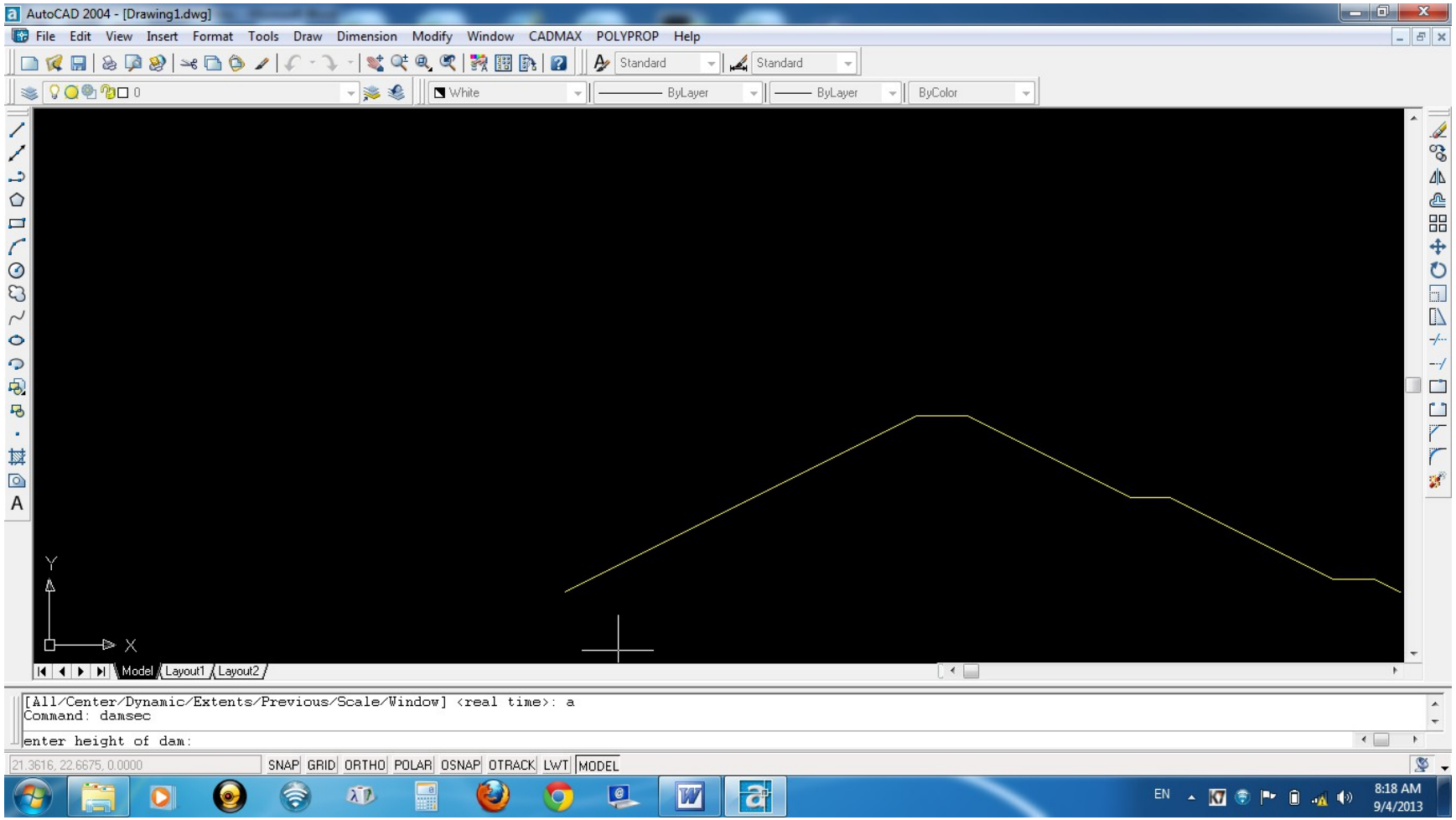
command:damsec

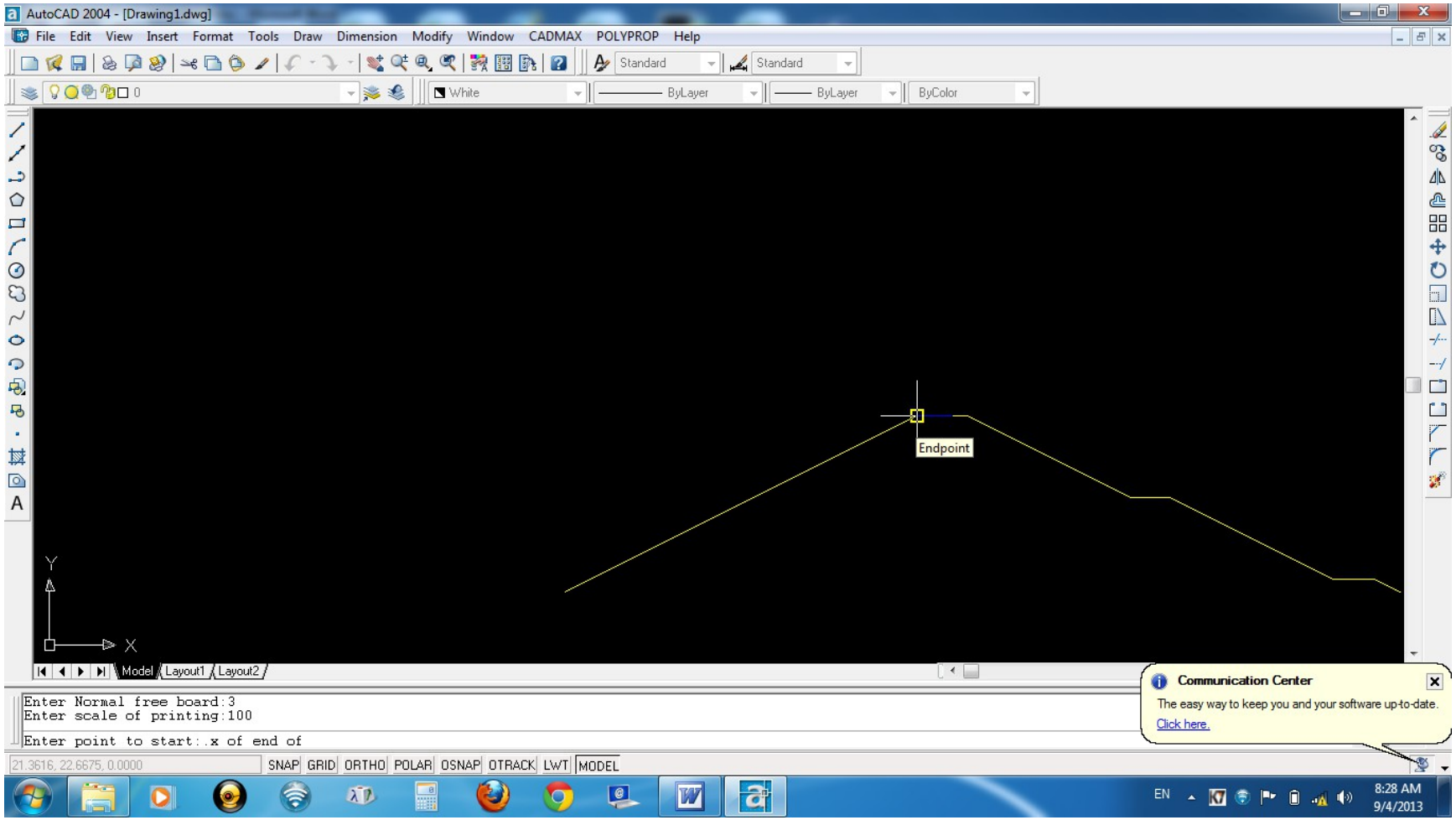
Now all the layers will be turned off except SPZ outer line and you will be prompted for height of Dam, top width of dam, R.L.of N.G.L., Minimum Free board, Normal Free board, Scale of printing ,Start Point for detailed drawing. The start point is to be selected as .x of (top left corner of SPZ) and yz of (bottom left corner of

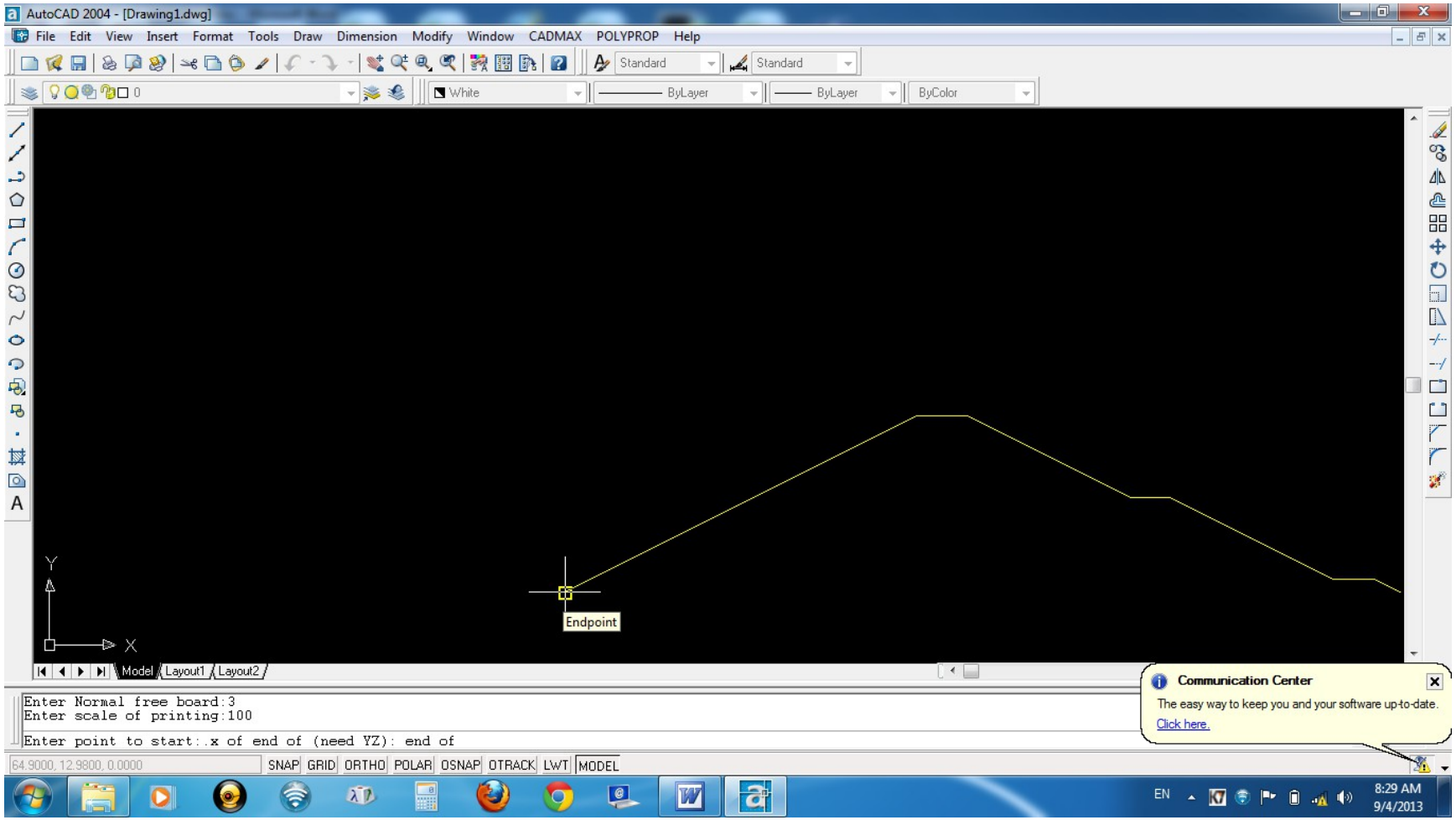
SPZ).Upstream slopes, upstream revetment details, downstream slopes, top soil removal depth, toe filter details, parapet wall details. The given details are shown below. When all prompted details are given correctly , the detailed drawing to field is created.

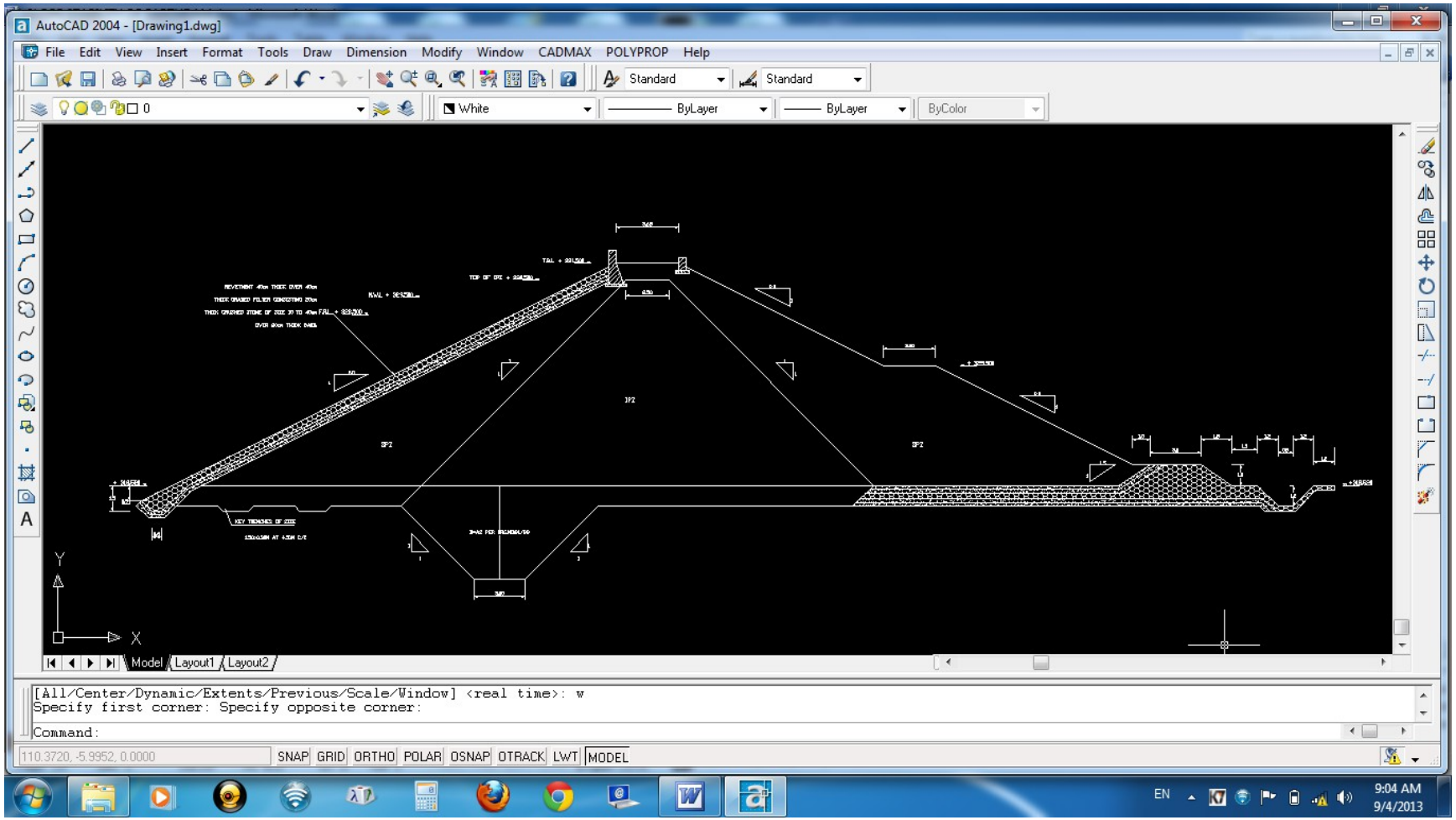
Command: damsec
enter height of dam:12.98
enter top width of dam:3.65
Enter R.L. of N.G.L:318.52
Enter Minimum free board:2
Enter Normal free board:3
Enter scale of printing:100
Enter point to start:.x of end of (need YZ): end of enter upstream slopes:2,1
enter height of slope:12.98
Enter thickness of revetment:0.4
Enter coarse filter thickness:0.2
Enter fine filter thickness:0.2
Enter top soil removal depth:1.2
Enter toe filter depth:1.2
Enter height of rock toe:1.2
Enter depth of fine sand in toe filter:0.2
Enter depth of coarse sand toe filter:0.25
Enter depth of broken stone filter:0.3
enter downstream slope:2,1
enter height of slope:6
enter downstream slope:3,0
enter height of slope:0

enter downstream slope:2,1
enter height of slope:6.98
Enter height of parapet upstream side:0.75
Enter depth of parapet foundation upstream side:1.2
Command:


AutoCAD 2004 - [Drawing1.dwg]
File Edit View Insert Format Tools Draw Dimension Modify Window CADMAX POLYPROP Help
Standard
Standard
White
ByLayer
ByLayer
ByColor
Y
X
Model
Layout1
Layout2
[All/Center/Dynamic/Extents/Previous/Scale/Window] <real time>: a
Command: damsec
enter height of dam:
21.3616, 22.6675, 0.0000
SNAP GRID ORTHO POLAR OSNAP OTRACK LWT MODEL
EN
8:18 AM
9/4/2013


AutoCAD 2004 - [Drawing1.dwg]
File Edit View Insert Format Tools Draw Dimension Modify Window CADMAX POLYPROP Help
Standard
Standard
White
ByLayer
ByLayer
ByColor
Endpoint
Y
X
Model
Layout1
Layout2
Enter Normal free board:3
Enter scale of printing:100
Enter point to start:.x of end of
21.3616, 22.6675, 0.0000
SNAP GRID ORTHO POLAR OSNAP OTRACK LWT MODEL
Communication Center
The easy way to keep you and your software up-to-date.
Click here.
EN
8:28 AM
9/4/2013

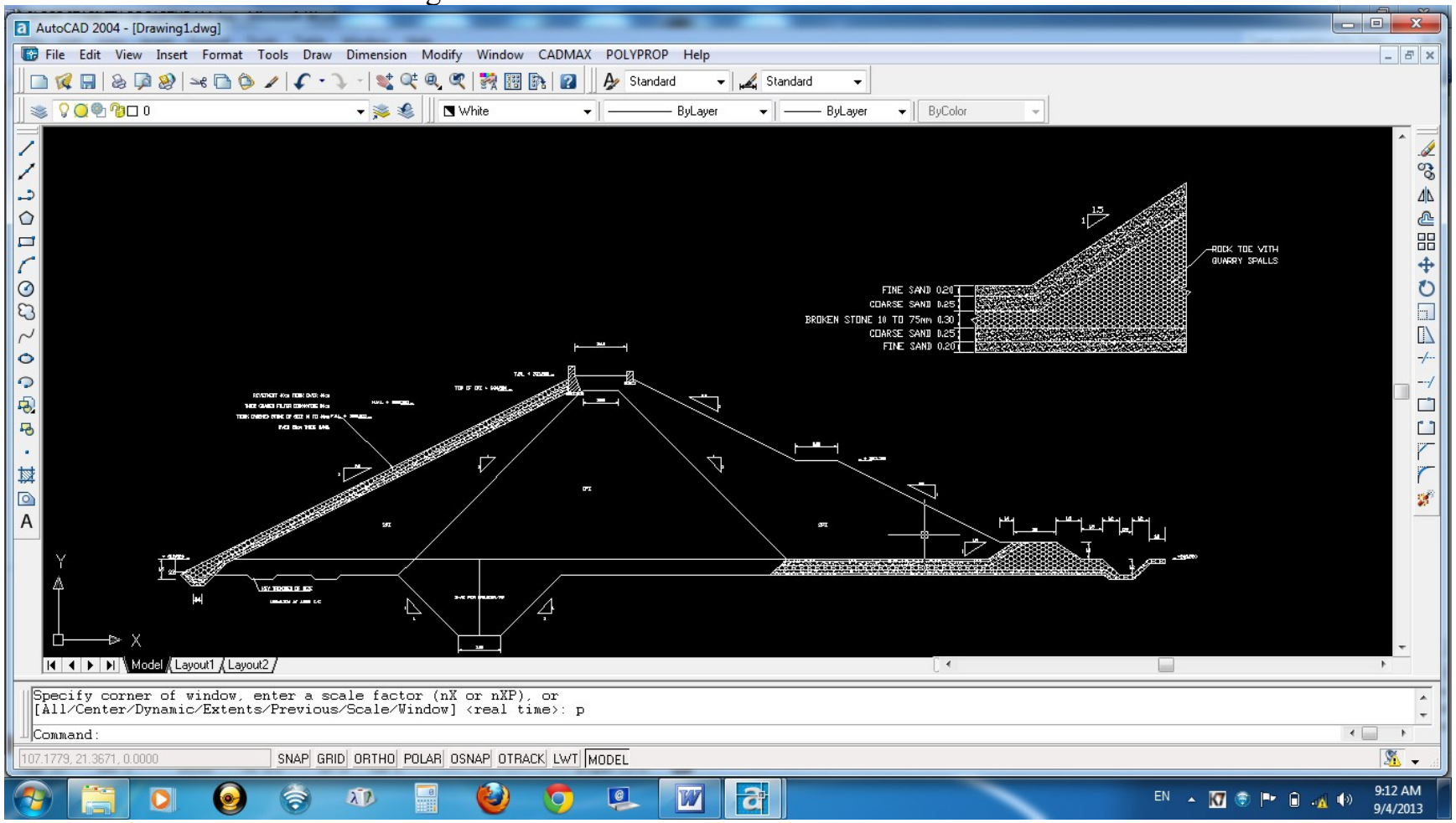

AutoCAD 2004 - [Drawing1.dwg]
File Edit View Insert Format Tools Draw Dimension Modify Window CADMAX POLYPROP Help
Standard
Standard
White
ByLayer
ByLayer
ByColor
Endpoint
Model Layout1 Layout2
Communication Center
The easy way to keep you and your software up-to-date.
Click here.
Enter Normal free board:3
Enter scale of printing:100
Enter point to start:.x of end of (need YZ): end of
64.9000, 12.9800, 0.0000
SNAP GRID ORTHO POLAR OSNAP OTRACK LWT MODEL
EN
8:29 AM
9/4/2013



Now the detailed Drawing is created.

Now give ROCTOE command at the command propmpt. In will ask for insertion point. You can locate it at top right corner of the drawing area.

Command: roctoe
Enter insertion point:
command:
You will see the roctoe details as given below.



Thai is all. The slope stability analysis of earth dam is over and detailed construction drawing is also ready. You can try this program for your earth dam stability analysis.
You contact me at mksugumaran@gmail.com